MAT.08.PT.4.WTANK.A.271

Sample Item ID:	MAT.08.PT.4.WTANK.A.271
Title:	Water Tower Options
Grade:	08
Primary Claim:	**Claim 4: Modeling and Data Analysis** Students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems.
Secondary Claim(s):	Claim 1: Concepts and Procedures Students can explain and apply mathematical concepts and carry out mathematical procedures with precision and fluency. Claim 2: Problem Solving Students can solve a range of well-posed problems in pure and applied mathematics, making productive use of knowledge and problem-solving strategies.
Primary Content Domain:	**Geometry**
Secondary Content Domain(s):	Ratios and Proportional Relationships, Statistics and Probability
Assessment Target(s):	4 A: Apply mathematics to solve problems arising in everyday life, society, and the workplace. 1 H: Understand and apply the Pythagorean theorem. 1 I: Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres. 1 A (Gr. 7): Analyze proportional relationships and use them to solve real-world and mathematical problems. 1 G (Gr. 7): Use random sampling to draw inferences about a population. 1 A (Gr. 6): Understand ratio concepts and use ratio reasoning to solve problems. 2 A: Apply mathematics to solve well-posed problems arising in everyday life, society, and the workplace. 2 B: Select and use appropriate tools strategically. 4 B: Construct, autonomously, chains of reasoning to justify mathematical models used, interpretations made, and solutions proposed for a complex problem. 4 G: Identify, analyze, and synthesize relevant external resources to pose or solve problems.
Standard(s):	8.G.9, 8.G.7, 7.SP.2, 7.RP.3, 6.RP.3
Mathematical Practice(s):	1, 2, 3, 4, 5, 6, 7, 8
DOK:	4

Grade 8 Mathematics Sample PT Form

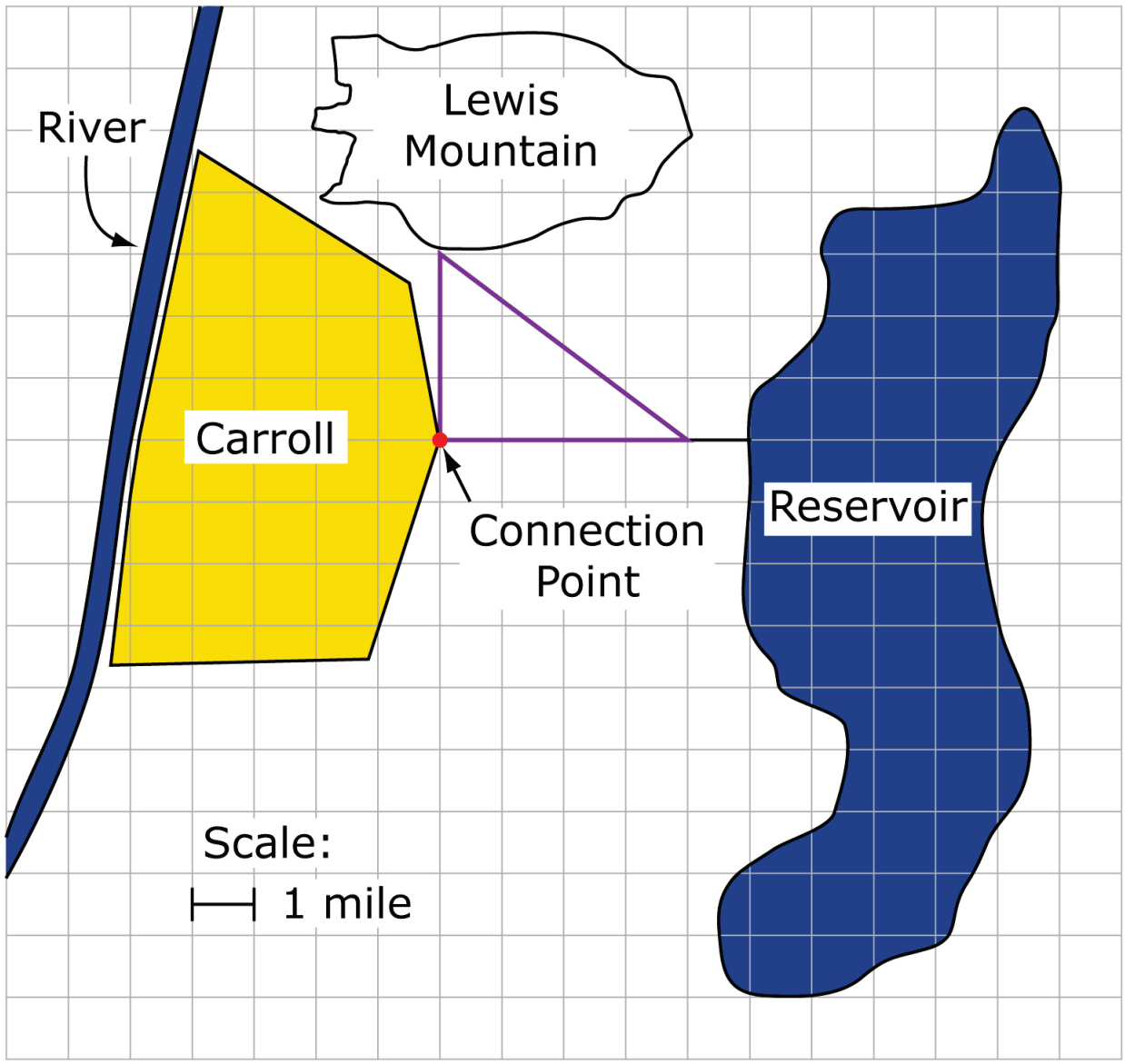
Item Type:	PT
Score Points:	16
Difficulty:	M
How this task addresses the "sufficient evidence" for this claim:	The student uses concepts of geometry, number and operations, and statistics to determine the best solution to a problem where all constraints cannot be satisfied at the same time. Additionally, the student must provide justifications to support reasoning.
Target-Specific Attributes (e.g., accessibility issues):	Accommodations may be necessary for students who have visual challenges. Calculator and spreadsheet needed.
Stimulus/Source:	http://www.lifewater.org/resources/rws5/rws5d3.pdf http://www.nesc.wvu.edu/pdf/dw/publications/ontap/2009_tb/reservoirs_towers_tanks_DWFSOM15.pdf http://www.howstuffworks.com/water.htm
Notes:	Multi-part task
Task Overview:	During the task, the student assumes the role of a member of the finance committee of a town council who is given the responsibility of determining the best plan for constructing a water tank or tower for the town. The student completes tasks in which he or she investigates the costs associated with building the water tank or tower in different locations, as well as the costs associated with the different designs, and then combines this information with some survey data to make a recommendation to the council. This investigation is done in class using spreadsheets and a calculator.
Teacher Preparation/Resource Requirements:	The day before the administration of the task, there is a prework task that will be used to get students thinking about the problem. The prework involves a teacher-led class discussion. The remainder of the task should be completed individually over two 1-hour sessions. During Session 1, students will be expected to make a number of calculations that will require the use of spreadsheets and calculators. During Session 2, students may need to finish the work from the previous day, but they need to be sure to set aside time to think about the benefits and costs of the different options and write a final recommendation.
Teacher Responsibilities During Administration:	Monitor individual student work; provide resources as necessary.
Time Requirements:	One pretask session that requires no more than 30 minutes of small-group and class work. Two sessions of scored individual work totaling no more than 120 minutes.

Prework:

In preparation for this task, teachers need to guide a class discussion about the considerations that need to be made when constructing a water tank or water tower for a town. It is best if this discussion takes place one to two days before the performance task is administered.

During the discussion, every student needs to be able to see the map that accompanies the performance task, whether on a screen at the front of the class, on a paper copy, or by some other method.

Teacher says: In the next few days, you will be working on a performance task. In the task, a new water tank or water tower for a town needs to be built, and your job is to recommend the best solution for the town.



Teacher continues: The map shows the location of the reservoir from which the water supply will be coming, the town of Carroll, the connection point between the town water

system and the water from the reservoir, and a mountain outside of town. A structure is needed to hold the water before it is used in order to provide a constant water pressure throughout the town. The options are to build a water tank on the mountain outside of town or to build a water tower at the connection point. Today we are going to brainstorm the costs and other factors associated with building either a water tank on the mountain or a water tower at the connection point so that the best recommendation can be presented.

Teacher asks: First, what costs would be associated with building a water tank on the mountain outside of town? What other factors should be considered?

As students brainstorm ideas, the ideas should be recorded.

Teacher asks: Now, what costs would be associated with building a water tower at the connection point on the edge of town? What other factors should be considered?

As students brainstorm ideas, the ideas should be recorded.

Teacher asks: Before we end, is there anything else that we forgot that we need to consider?

Record any final ideas that the students have. Consider asking probing questions if students have missed any of the following topics or do not understand why the following topics are important: the height of the tank/tower, the capacity of the tank/tower, the cost of the water pipes to and from the tank/tower, and the cost of the land.

Close the activity and save the lists of students' ideas for the following day.

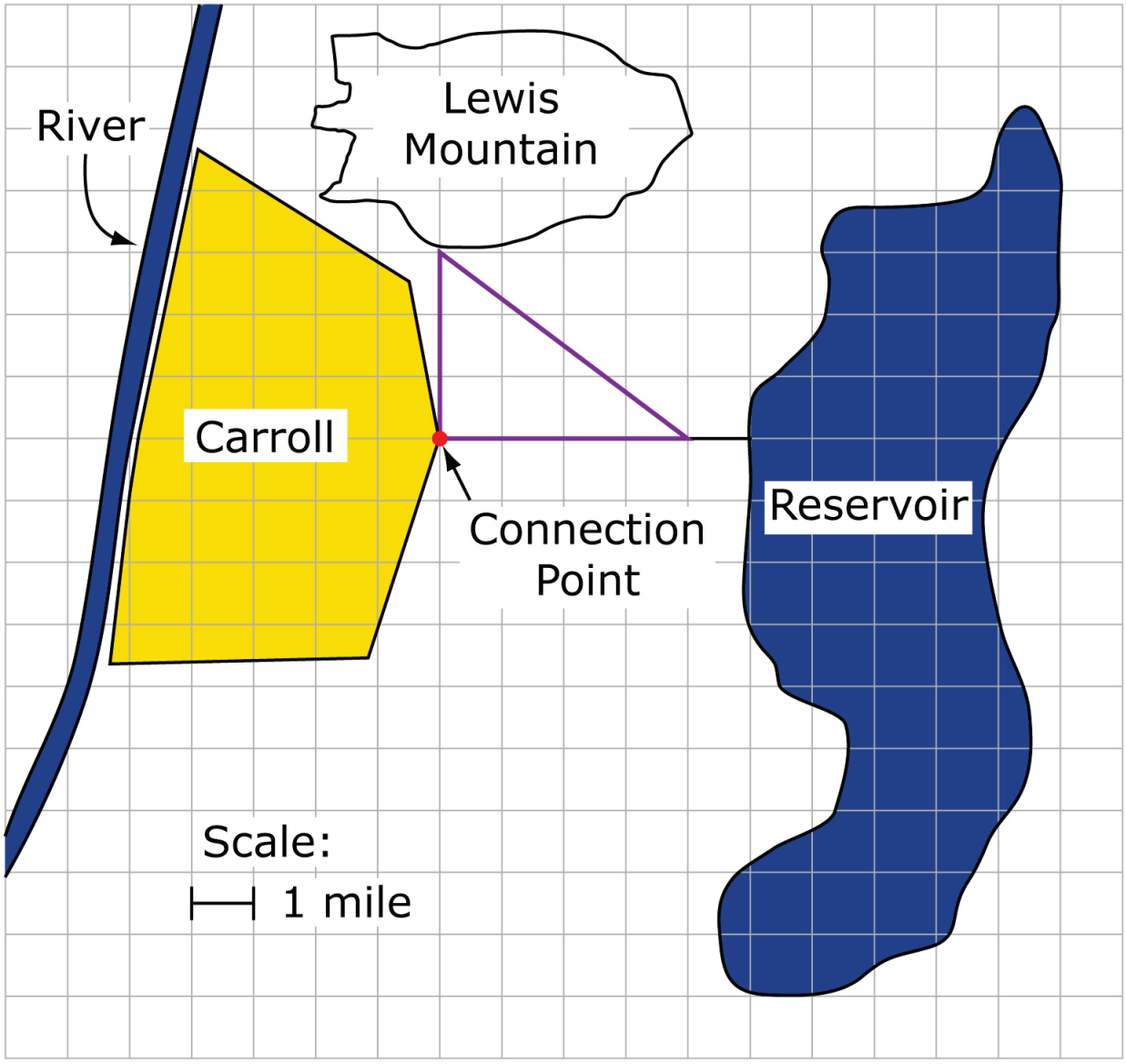
Water Tank or Water Tower?

Session 1

The population of Carroll is approximately 20,000 and has remained constant for the last 20 years. Carroll currently uses an outdated water supply system to get its water from a nearby river. The outdated system will be replaced by a system that draws from a reservoir.

Members of the finance committee on the Carroll town council are responsible for investigating the costs of a new water treatment plant. As one of the finance committee members, you must make a recommendation that will best meet the needs of the town at this time. The two options are as follows:

- Building a water tank on Lewis Mountain
- Building a water tower at a connection point on the edge of town



You must first determine the costs based on the packet of information provided by four companies bidding on the town's new water treatment plant. After analyzing the information provided, you will summarize your findings and write a report to the town council that includes your recommendation.

[The packet of information referred to here is attached to this item, following the rubric.]

To begin, answer the following questions.

1. How high does the water tank need to be above the highest elevation in town?
2. What is the minimum size of each design (reservoir, Hydrosphere, and Watercolumn) that could be used to meet the needs of the town?
3. What is the cost to construct the minimum size of each design, including the tower if necessary?
4. What is the cost of the pipe for each design?
5. What is the cost of the land for each design?

You have information and estimates from the following companies to help you answer the questions.

- Thomas Tanks & Towers, Inc.
- William Brown Polls
- Nguyen Construction Co.
- Ravi Patel Real Estate

Be sure to clearly label your answers for each question. Show all work necessary to support your answers using diagrams, pictures, expressions/equations, or words as appropriate.

A calculator tool[1] and a spreadsheet tool[2] are available by clicking on the appropriate icon for each in the top right corner. Answers may be written or displayed in the spreadsheet and saved as part of your response.

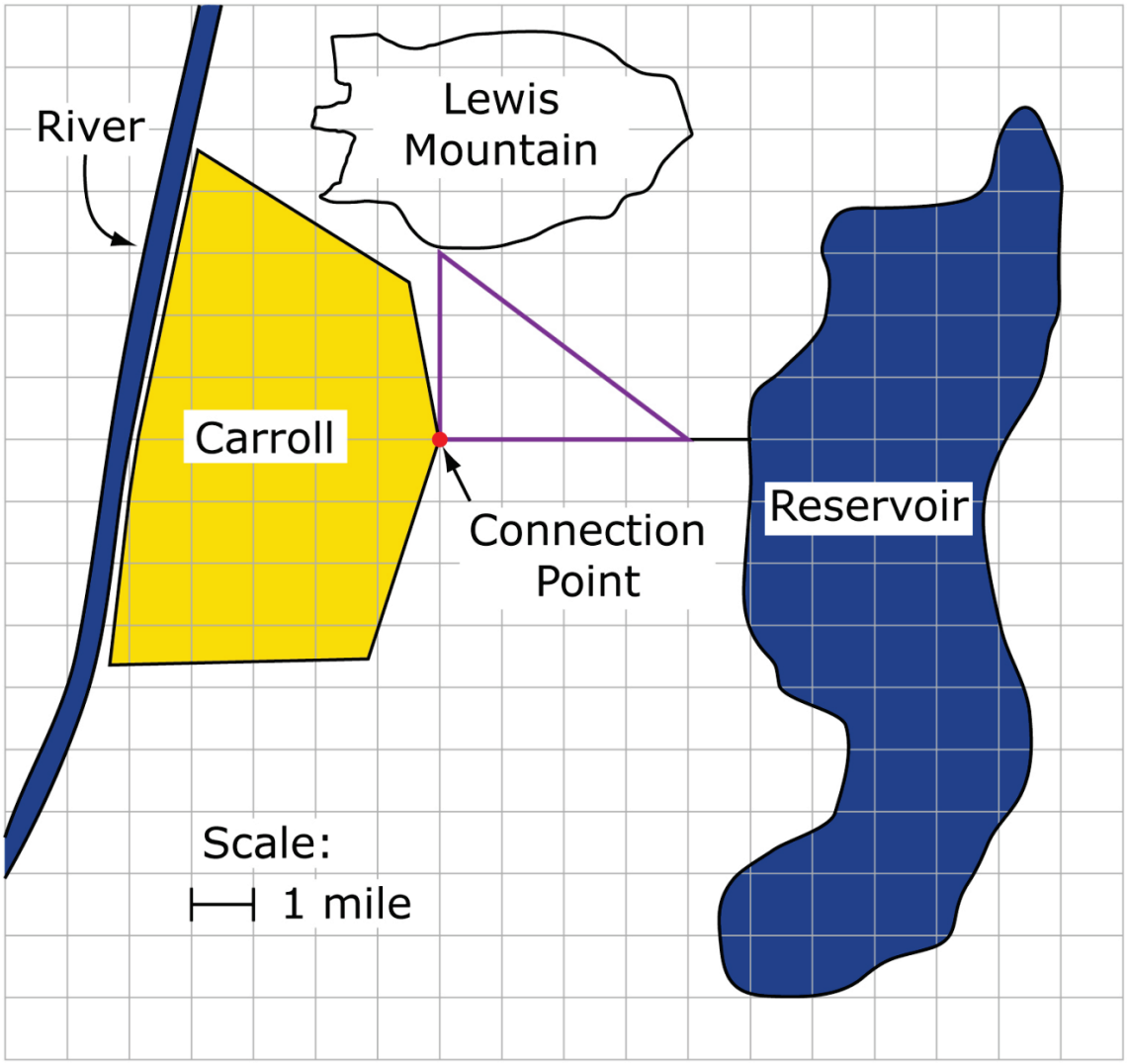
[1] The technology platform will have to allow for at least a scientific calculator for this task.
[2] The technology platform should allow for a basic spreadsheet interface that can be used, with the results or snapshot of the spreadsheet included as part of the student's response.

Session 2

Now that you have determined the costs of the different designs, you need to write your report and make a recommendation to the town council.

The following questions will guide your report. To support your answers to these questions, you must include the following:

- Cost estimates gathered from your work completed in Session 1 of this task
- Survey information provided in the information packet



6. What are the positives and negatives of building a water tank on Lewis Mountain? Be sure to give the most complete answer that you can.

7. What are the positives and negatives of building a water tower at the connection point? Be sure to give the most complete answer that you can.

8. What is your recommendation to the other members of the town council in Carroll? Be sure to give the most complete answer that you can.

Sample Top-Score Response:

Session 1:

1. How high does the water tank need to be above the highest elevation in town?

According to Thomas Tanks & Towers, Inc., for each foot that the water tower is above the highest elevation in town, the water pressure increases by 0.43 pounds per square inch (PSI). Thomas Tanks & Towers, Inc., recommends maintaining a water pressure between 50 and 100 pounds per square inch (PSI).

In order to minimize the height that the water tank needs to be above the highest elevation in town, and thus minimize the cost associated with building a tower, I calculate the height needed to maintain a pressure of at least 50 PSI:

$$\frac{50}{0.43} \approx 116.28 \text{ feet}$$

So the height needed to maintain a pressure of at least 50 PSI is about 117 feet above the highest elevation in town.

2. What is the minimum size of each design (reservoir, Hydrosphere, and Watercolumn) that could be used to meet the needs of the town?

If the tank is built at the connection point, a tower of about 117 feet will be needed. If the tank is built on Lewis Mountain, a tower does not need to be built, because the parcels of land available on the mountain are approximately 150 feet above the highest elevation in town.

According to the information provided, the population of Carroll is approximately 20,000 and has remained constant for the last 20 years. Since the population has remained constant, I will determine what size water tank would be needed for 20,000 people.
Thomas Tanks & Towers, Inc., recommends that the tank hold about a day's worth of water for the community. The average person uses about 90 gallons of water per day. I calculate the total volume of water needed to be held in the tank:

$$20{,}000 \times 90 = 1{,}800{,}000 \text{ gallons of water}$$

So the tank will need to hold 1,800,000 gallons of water. Next I figure out the volume that the tank would need to have in order to hold 1,800,000 gallons of water. Since one cubic foot holds approximately 7.5 gallons of water, the tank will need to have a volume of $1{,}800{,}000 / 7.5 = 240{,}000$ cubic feet.
Since the options of the water tank have different shapes and sizes, I need to determine which of these has a volume of at least 240,000 cubic feet.

Ground Level Cylindrical Reservoir Options:
Since this is a cylinder, the volume of water that can be held by the tank is $\pi r^2 h$ cubic feet, where r is the radius and h is the height of the tank. I used a spreadsheet to calculate the volumes and rounded to the nearest cubic foot, shown below.

Diameter (feet)	Height (feet)	Volume (cubic feet)
48	40	72,382
58	40	105,683
67	40	141,026
94	40	277,591
115	40	415,476
148	40	688,134

If I were to choose a Ground Level Cylindrical Reservoir that would both minimize cost and have adequate capacity, the tank would need a diameter of 94 feet and a height of 40 feet. Since this is a ground-level tank, it would need to be built on Lewis Mountain, and thus wouldn't require a tower.

Hydrosphere Water Tower Options:
Since this is a sphere, the volume of water that can be held by the tank is $\frac{4}{3}\pi r^3$ cubic feet, where r is the radius of the tank. I used a spreadsheet to calculate the volumes and rounded to the nearest cubic foot, shown below.

Diameter (feet)	Volume (cubic feet)
52	73,622
59	107,536
65	143,793
70	179,594
75	220,893
81	278,262

If I were to choose a Hydrosphere Water Tower that would both minimize cost and have adequate capacity, the tank would need a diameter of 81 feet. Since this is a water tower, it would need to be built at the connection point, and thus it would require a tower of approximately 117 feet.

Watercolumn Water Tower Options:
This tank is a cylinder and part of a cone. According to the information provided, the height of the upper cylindrical section of a Watercolumn Water Tower is half of the head range. The volume of the tank in the lower section of a Watercolumn is 70% of the volume in the upper cylindrical section. Thus, the total volume of water that can be held by the tank is $1.7\pi r^2 h$ cubic feet, where r is the radius and h is the height of the cylindrical section of the tank. I used a spreadsheet to calculate the volumes and rounded to the nearest cubic foot, shown below.

Diameter (feet)	Head Range (feet)	Volume (cubic feet)
58	32	71,865
64	40	109,378
74	40	146,229
80	40	170,903
90	40	216,299
100	42	280,387
108	44	342,617
120	42	403,757
125	45	469,398
135	45	547,506

If I were to choose a Watercolumn Water Tower that would both minimize cost and have adequate capacity, the tank would need a diameter of 100 feet and a height of 42 feet. Since this is a water tower, it would need to be built at the connection point, and thus it would require a tower of approximately 117 feet.

3. What is the cost to construct the minimum size of each design, including the tower if necessary?

Again, I will look only at tanks that both minimize cost and have adequate capacity.

Ground Level Cylindrical Reservoir Option:
According to Thomas Tanks & Towers, Inc., the cost of the Ground Level Cylindrical Reservoir with a diameter of 94 feet and a height of 40 feet is $2,500,000. Since this would be built on Lewis Mountain, no tower is needed.

Hydrosphere Water Tower Option:
According to Thomas Tanks & Towers, Inc., the cost of the Hydrosphere Water Tower with diameter of 81 feet is $3,220,000. Since this would be built at the connection point, a 117-foot tower is needed. According to the information provided, the

construction costs are \$300 for each foot that the tank is raised above the ground, so the tower would cost $117 \times \$300 = \$35{,}100$. Therefore, the cost of this water tank/tower option is $\$3{,}220{,}000 + \$35{,}100 = \$3{,}255{,}100$.

Watercolumn Water Tower Options:
According to Thomas Tanks & Towers, Inc., the cost of the Watercolumn Water Tower with a diameter of 100 feet and a height of 42 feet is \$3,020,000. Since this would be built at the connection point, a 117-foot tower is needed. According to the information provided, the construction costs are \$300 for each foot that the tank is raised above the ground, so the tower would cost $117 \times \$300 = \$35{,}100$. Therefore, the cost of this water tank/tower option is $\$3{,}020{,}000 + \$35{,}100 = \$3{,}055{,}100$.

4. What is the cost of the pipe for each design?

For the Ground Level Cylindrical Reservoir, since this would be built on Lewis Mountain, I find the length of pipe needed from the reservoir to the mountain, the length of pipe needed from the mountain to the connection point, and the cost of building pipes from the bottom of the mountain to the tank.
According to the map, a portion of the pipe from the reservoir to the mountain appears to be the hypotenuse of a right triangle with legs of length 3 and 4. By the Pythagorean theorem, the length of this portion is $\sqrt{3^2 + 4^2} = 5$ miles. So based on the map, there should be $1 + 5 = 6$ miles of pipe from the reservoir to the mountain and 3 miles of pipe from the mountain to the connection point. Nguyen Construction estimates that the cost of constructing the water pipe would be \$4,300,000 per mile, and the cost of building pipes from the bottom of the mountain to the tank would be an additional \$700,000. Thus, the cost of pipe needed for this water tank would be $9 \times \$4{,}300{,}000 + \$700{,}000 = \$39{,}400{,}000$ for this option.
For the Hydrosphere Water Tower and Watercolumn Water Tower, since these would be built at the connection point on the edge of town, I find the length of pipe needed from the reservoir to the connection point. According to the map, there should be a total of $1 + 4 = 5$ miles of pipe. Nguyen Construction estimates that the cost of constructing the water pipe would be \$4,300,000 per mile. Thus, the cost of pipe needed for these water towers would be $5 \times \$4{,}300{,}000 = \$21{,}500{,}000$ for either of these options.

5. What is the cost of the land for each design?

The Ground Level Cylindrical Reservoir would be built on Lewis Mountain, which Ravi Patel Real Estate expects to cost \$9,000 per acre. According to Thomas Tanks & Towers, Inc., 10 acres of land are required for a Ground Level Cylindrical Reservoir. Thus, the cost of land for this option is $\$9{,}000 \times 10 = \$90{,}000$.
The Hydrosphere Water Tower and Watercolumn Water Tower would be built at the connection point, which Ravi Patel Real Estate expects to cost \$55,000 per acre. According to Thomas Tanks & Towers, Inc., 5 acres of land are required for either water tower. Thus, the cost of land for either option is $\$55{,}000 \times 5 = \$275{,}000$.

Session 2:

6. What are the positives and negatives of building a water tank on Lewis Mountain? Be sure to give the most complete answer that you can.

Here are the costs associated with building a Ground Level Cylindrical Reservoir on

Lewis Mountain:

- Cost of water tank: $2,500,000
- Cost of pipe: $39,400,000
- Cost of land: $90,000
- Total construction cost: $\$2{,}500{,}000 + \$39{,}400{,}000 + \$90{,}000 = \$41{,}900{,}090$

The positive of building a water tank on Lewis Mountain is that, according to William Brown Polls, about 55% of the population of Carroll prefer that the water tank be built on Lewis Mountain. The negative is that it costs a lot more than the other two options.

7. What are the positives and negatives of building a water tower at the connection point? Be sure to give the most complete answer that you can.

   Here are the costs associated with building a Hydrosphere Water Tower at the connection point:

   - Cost of water tank: $3,255,100
   - Cost of pipe: $21,500,000
   - Cost of land: $275,000
   - Total construction cost: $\$3{,}255{,}100 + \$21{,}500{,}000 + \$275{,}000 = \$25{,}030{,}100$

   Here are the costs associated with building a Watercolumn Water Tower at the connection point:

   - Cost of water tank: $3,055,100
   - Cost of pipe: $21,500,000
   - Cost of land: $275,000
   - Total construction cost: $\$3{,}055{,}100 + \$21{,}500{,}000 + \$275{,}000 = \$24{,}830{,}100$

   The positive of building a water tower at the connection point is that it will cost the town much less than building a water tank on Lewis Mountain. The negative is that the population of the town would prefer to have the tank built on Lewis Mountain.

8. What is your recommendation to the other members of the town council in Carroll? Be sure to give the most complete answer that you can.

   I recommend that the town of Carroll build a Watercolumn Water Tower, with a diameter of 100 feet and a height of 42 feet, at the connection point. This water tower will have a water capacity and pressure that is adequate for the town's population and will minimize the total construction cost.
   The costs associated with building a Watercolumn Water Tower at the connection point are as follows:

   - Cost of water tank: $3,055,100

- Cost of pipe: $21,500,000
- Cost of land: $275,000
- Total construction cost: $\$3{,}055{,}100 + \$21{,}500{,}000 + \$275{,}000 = \$24{,}830{,}100$

I recognize that 55% of the population of Carroll did not prefer to build a water tower at the connection point, but the cost of building a water tank on Lewis Mountain ($41,900,090) was not feasible. However, in order to appease the public and strengthen town pride, I further recommend that a design featuring the high school mascot be put on the tank.

Scoring Notes: Each scored portion of the task is evaluated individually. The total number of points is determined by adding the points assigned for each task.

Scoring Rubric:

Question 1: *Responses to this question will receive 0–1 point, based on whether the student correctly answers the question. This question is a one-step problem, so it is straightforward.*

Question 2: *Responses to this item will receive 0–3 points, based on the following:*

3 points: The student shows a thorough understanding of how to find the volume of cylinders and spheres. The student finds correct volumes and determines the number of gallons that each tank holds.

2 points: The student shows a partial understanding of how to find the volume of cylinders and spheres. The student performs many aspects of the task correctly but demonstrates some misunderstandings, such as neglecting to determine the number of gallons that each tank holds or using the diameter instead of the radius to determine the volume.

1 point: The student shows a limited understanding of how to find the volume of cylinders and spheres. The student makes some correct calculations but does not demonstrate understanding of the volume of both cylinders and spheres.

0 points: The student shows inconsistent or no understanding of how to find the volume of cylinders and spheres. The student makes numerous errors in calculating the volume of the cylinders and spheres.

Question 3: *Responses to this item will receive 0–2 points, based on the following:*

2 points: The student shows a thorough understanding of determining the cost of each option. The student uses the tables to find the cost of the smallest tank that could be used for each design and includes the cost for the tower where needed.

1 point: The student shows a partial understanding of determining the cost of each option.

The student makes minor errors when using the tables to find the cost of the smallest tank that could be used for each design and including the cost for the tower where needed.

0 points: The student shows inconsistent or no understanding of determining the cost of each option. The student does not demonstrate the ability to use the tables to determine the cost of the smallest tank that could be used for each design, nor does the student calculate the cost of the tower.

Question 4: *Responses to this item will receive 0–2 points, based on the following:*

2 points: The student shows a thorough understanding of determining the cost of each option. The student uses the Pythagorean theorem and the additional $700,000 cost to find the cost of the pipes to and from the tank on Lewis Mountain, and multiplies to find the cost of the pipes to the water tower.

1 point: The student shows a partial understanding of determining the cost of each option. The student does not use the Pythagorean theorem or makes minor mathematical errors.

0 points: The student shows inconsistent or no understanding of determining the cost of each option. The student makes numerous errors in calculating the cost of the pipe for each option.

Question 5: *Responses to this item will receive 0–1 point, based on whether the student correctly answers the question. The calculations in this question are straightforward, so no partial credit is given for this question.*

Question 6: *Responses to this item will receive 0–2 points, based on the following:*

2 points: The student shows a thorough understanding of the benefits and costs of building a water tank on Lewis Mountain. The student includes all costs as well as the opinion of the community in the response.

1 point: The student shows a partial understanding of the benefits and costs of building a water tank on Lewis Mountain. The student considers only three of the four factors that need to be considered in making the decision.

0 points: The student shows inconsistent or no understanding of the benefits and costs of building a water tank on Lewis Mountain. The student considers less than three of the factors that need to be considered in making the decision.

Question 7: *Responses to this item will receive 0–2 points, based on the following:*

2 points: The student shows a thorough understanding of the benefits and costs of building a water tower on the outskirts of Carroll. The student includes all costs as well as the opinion of the community in the response.

1 point: The student shows a partial understanding of the benefits and costs of building a

water tower on the outskirts of Carroll. The student considers only three of the four factors that need to be considered in making the decision.

0 points: The student shows inconsistent or no understanding of the benefits and costs of building a water tower on the outskirts of Carroll. The student considers less than three of the factors that need to be considered in making the decision.

Question 8: *Responses to this item will receive 0–3 points, based on the following:*

3 points: The student shows a thorough understanding of how to analyze a complex scenario and construct a chain of reasoning to justify the solution to a scenario. The student includes all the different aspects of the task in the justification and provides evidence to support the conclusion made.

2 points: The student shows a partial understanding of how to analyze a complex scenario and construct a chain of reasoning to justify the solution to a scenario. The student includes many of the different aspects of the task in the justification and provides evidence to support the conclusion made, but some omissions are made.

1 point: The student shows a limited understanding of how to analyze a complex scenario and construct a chain of reasoning to justify the solution to a scenario. The student includes some of the different aspects of the task in the justification but makes a conclusion that would not have been made if all of the aspects of the task had been considered.

0 points: The student shows inconsistent or no understanding of how to analyze a complex scenario and construct a chain of reasoning to justify the solution to a scenario. The student makes a conclusion that is contradictory to the aspects of the task considered in the justification.

This packet contains information from Nguyen Construction Co., Ravi Patel Real Estate, William Brown Polls, and Thomas Tanks & Towers, Inc. to be used to determine the costs of the construction of a water tank or water tower for the town of Carroll.

THOMAS TANKS & TOWERS, INC.

REQUIRED TANK HEIGHT

- For each foot that the base of a water tank is above the highest elevation in town, the water pressure increases by 0.43 pounds per square inch (PSI).
- The construction costs are $300 for each foot that the tank is raised above the ground.

RECOMMENDED WATER PRESSURE

- We recommend maintaining a water pressure between 50 and 100 pounds per square inch (PSI).

RECOMMENDED WATER TANK CAPACITY

- We recommend that the tank hold about a day's worth of water for the community. The average person uses about 90 gallons of water per day.

GENERAL NOTES

- One cubic foot holds approximately 7.5 gallons.
- The cost of a reservoir, Hydrosphere, or Watercolumn does not include the cost to purchase the land, develop the land, or build the tower.

GROUND-LEVEL CYLINDRICAL RESERVOIR OPTIONS

Diameter (feet)	Height (feet)	Cost (dollars)
48	40	$650,000.00
58	40	$950,000.00
67	40	$1,270,000.00
94	40	$2,500,000.00
115	40	$3,730,000.00
148	40	$6,180,000.00

- 10 acres of land are required for a ground-level reservoir.
- A ground-level cylindrical reservoir cannot be constructed on top of a tower.

HYDROSPHERE WATER TOWER OPTIONS

Diameter (feet)	Cost (dollars)
52	$1,030,000.00
59	$1,400,000.00
65	$1,780,000.00
70	$2,170,000.00
75	$2,610,000.00
81	$3,220,000.00

Base of the water tank

- 5 acres of land are required for a Hydrosphere water tower.

WATERCOLUMN WATER TOWER OPTIONS

NOTES:

- The height of the upper cylindrical section of a Watercolumn is half of the head range.
- The volume of the lower noncylindrical section of the tank in a Watercolumn is 70% of the volume in the upper cylindrical section.

Diameter (feet)	Head Range (feet)	Cost (dollars)
58	32	$1,060,000.00
64	40	$1,410,000.00
74	40	$1,760,000.00
80	40	$1,990,000.00
90	40	$2,420,000.00
100	42	$3,020,000.00
108	44	$3,610,000.00
120	42	$4,190,000.00
125	45	$4,800,000.00
135	45	$5,540,000.00

- 5 acres of land are required for a Watercolumn water tower.

NGUYEN CONSTRUCTION CO.

Based on your requirements, we are pleased to offer an estimate of
___$20,000___ per acre to develop a site for a water tank or water tower.

This estimate includes:

- Grading and site preparation
- Foundation construction
- Parking lot and sidewalk construction
- Planting of grass seed and native shrubs and trees at the conclusion of the project

In addition, we estimate the cost to construct the water pipe at $4,300,000 per mile. If the water tank is constructed on Lewis Mountain, we estimate $700,00 to build pipes from the bottom of the mountain to the tank.

RAVI PATEL REAL ESTATE

We have researched the approximate costs for 10-acre parcels of land on Lewis Mountain and 5-acre parcels of land on the edge of the town of Carroll.

It is reasonable to expect to pay $9,000 per acre for land on Lewis Mountain. The parcels of land available on the mountain are approximately 150 feet above the highest elevation in town.

It is reasonable to expect to pay $55,000 per acre for land on the edge of the town of Carroll.

We look forward to providing assistance in the purchase of the land needed for this project.

WILLIAM BROWN POLLS

Thank you for allowing us the opportunity to serve your community. The questions used in our survey and the results are shown below.

Question 1: How strongly do you agree with the following statement? I would prefer for the new water tank to be built on a tower on the edge of town instead of on Lewis Mountain.

Response	Percent of the Population
Strongly agree	20%
Somewhat agree	15%
Neither agree nor disagree	10%
Somewhat disagree	10%
Strongly disagree	45%

Question 2: If the new water tank is built on a tower on the edge of town, what would you like to see in the space on the water tank? A design welcoming people to Carroll, a design featuring the high school mascot, or advertisements?

Response	Percent of the Population
A design welcoming people to Carroll	15%
A design featuring the highschool mascot	75%
Sell the space for advertising	10%

All percents shown are estimated to be correct within ±3%.

Please contact us if we can be of further service to your community.